

What is claimed is:

1. A composition comprising:

(a) a fluoropolymer comprising interpolymers derived from a nitrogen-containing cure site monomer;

(b) a catalyst composition that includes a compound having the general formula:

$\{RA\}^{(-)}\{QR'_k\}^{(+)}$ or the precursors thereof added separately or as a mixture;

wherein R is a C₁-C₂₀ alkyl or alkenyl, C₃-C₂₀ cycloalkyl or cycloalkenyl, or C₆-C₂₀ aryl or aralkyl, which may be nonfluorinated, partially fluorinated, or perfluorinated, A is an acid anion or an acid derivative anion, Q is phosphorous, sulfur, nitrogen, arsenic, or antimony, each R' is, independently, hydrogen or a substituted or unsubstituted C₁-C₂₀ alkyl, aryl, aralkyl, or alkenyl group, provided that when Q is nitrogen and the only fluoropolymer in the composition consists essentially of a terpolymer of tetrafluoroethylene, a perfluorovinylether, and a perfluorovinylether cure site monomer comprising a nitrile group not every R' is H, and k is the valence of Q; and

optionally (c) an alcohol of the general formula R²-OH, wherein R² is an alkyl group having from 1 to 20 carbon atoms, and wherein R² can be fluorinated.

2. A composition according to claim 1 wherein A is selected from the group consisting of: COO, O when R is aryl or alkylaryl, SO₃, SO₂, SO₂NH, PO₃, CF₃CF(CF₃)CH₂O, C_nF_{2n+1}CH₂O

wherein n is 0 to 100, CH₂OPO₃, (CH₂O)₂PO₂, C₆H₄O, OSO₃, SO₂NR', SO₂NSO₂R', and SO₂CRSO₂R', wherein R' is as defined in claim 1.

3. A composition according to claim 1 wherein R is selected from a non-fluorinated, partially-fluorinated, or perfluorinated group.

4. A composition according to claim 1 wherein RA has the general formula selected from RCOOM, ROSO₃M, RSO₃M, and ROM, wherein M is hydrogen, or an alkali or alkaline earth metal.

5. A composition according to claim 1 wherein RA is selected from the formula R_x-Ph_y-{(CH₂)_n-D}_m wherein each R_x is the same or different C₁-C₁₀ alkenyl or alkyl, x is 0 to 5, y is 0 or 1, n is 0 to 10, m is 1 to 5, and D is selected from COO, OSO₃, SO₃, and O (when y

is 1), provided that the sum of x and m is 6 or less and provided that x and y are not both zero; RCOO wherein R is alkenyl, an alkyl of 1 to 10 carbon atoms, or an aryl of 6 to 20 carbon atoms; $(^{-})\text{OOC}-(\text{CX}_2)_n-\text{COO}^{(-)}$ wherein n is 0 to 10, X = H, F, or Cl; and $\text{Ph}-((\text{CH}_2)_p-\text{COO}^{(-)})_q$ wherein p and q are independently 1 to 4; $\text{CF}_3\text{CF}(\text{CF}_3)\text{CH}_2\text{O}$ or $\text{C}_n\text{F}_{2n+1}\text{CH}_2\text{O}$ wherein n is 0 to 100; and blends of two or more such compounds.

6. A composition according to claim 1 wherein RA is selected from the general formula $(^{-})\text{O}_z-\text{Ph}-\text{G}_y-\text{Ph}-\text{O}_z^{(-)}$ wherein G is a bond or a difunctional aliphatic, cycloaliphatic, or C_1-C_{13} aromatic radical, or a thio, oxy, carbonyl, sulfinyl, or sulfonyl radical, G and/or Ph are optionally substituted with at least one Cl or F atom, y is 0 or 1, each z is, independently, 1 or 2, and any aromatic ring of the polyoxy compound is optionally substituted with at least one atom of Cl, F, or Br atom, or carboxyl, or an acyl radical, or an alkyl radical; and blends of two or more such compounds.

7. A composition according to claim 1 wherein RA is selected from the general formula $(^{-})\text{O}-\text{Ph}-\text{C}(\text{CX}_3)_2-\text{Ph}-\text{O}^{(-)}$, wherein X is H, Cl, or F; and blends of two or more such compounds.

8. A composition according to claim 1 wherein QR'_k is selected from tetramethylphosphoniums, tributylallylphosphoniums, tributylbenzylphosphoniums, dibutyldiphenylphosphoniums, tetrabutylphosphonium, tributyl(2-methoxy) propylphosphoniums, triphenylbenzylphosphoniums, and tetraphenylphosphoniums.

9. A composition according to claim 1 wherein QR'_k is selected from phenyltrimethylammoniums, tetrapentylammoniums, tetrapropylammoniums, tetrahexylammoniums, tetraheptylammoniums, tetramethylammoniums, tetrabutylammoniums, tributylbenzyl ammoniums, tributylallylammoniums, tetrabenzylammoniums, tetraphenylammoniums, diphenyl diethylamino ammoniums, triphenylbenzylammoniums, 8-benzyl-1,8-diazabicyclo[5.4.0]undec-7-eniums, benzyltris(dimethylamino) phosphoniums, and bis(benzylidiphenyl phosphine)iminiums.

10. A composition of claim 1 wherein the catalyst composition is prepared in situ.

11. A composition according to claim 1 wherein the catalyst composition is prepared from components dissolved in a solvent.

12. A composition according to claim 1 wherein the fluoropolymer comprises
interpolymerized units derived from (i) tetrafluoroethylene, and optionally (ii) one or more
perfluorovinyl ethers of the formula: $\text{CF}_2=\text{CFO}(\text{R}^2_{\text{f}}\text{O})_a(\text{R}^3_{\text{f}}\text{O})_b\text{R}^4_{\text{f}}$
wherein R^2_{f} and R^3_{f} are the same or are different linear or branched perfluoroalkylene groups of
1-6 carbon atoms; a and b are, independently, 0 or an integer from 1 to 10; and R^4_{f} is a
perfluoroalkyl group of 1-6 carbon atoms.

13. A composition according to claim 12 wherein the fluoropolymer further comprises
interpolymerized units derived from monomers selected from the group consisting of
perfluoroolefins, partially-fluorinated olefins, non-fluorinated olefins, vinylidene fluoride, and
combinations thereof.

14. A composition according to claim 1 wherein said cure site monomer is selected from a
fluorinated olefin and a nitrile-containing monomer.

15. A composition according to claim 1 wherein said cure site monomer is a nitrile-
containing monomer having the formula $\text{CF}_2=\text{CFO}(\text{CF}_2)_L\text{CN}$; $\text{CF}_2=\text{CFO}(\text{CF}_2)_u\text{OCF}(\text{CF}_3)\text{CN}$;
 $\text{CF}_2=\text{CFO}[\text{CF}_2\text{CF}(\text{CF}_3)\text{O}]_q(\text{CF}_2\text{O})_y\text{CF}(\text{CF}_3)\text{CN}$; or $\text{CF}_2=\text{CF}[\text{OCF}_2\text{CF}(\text{CF}_3)]_r\text{O}(\text{CF}_2)_t\text{CN}$;
wherein $L = 2-12$; $q = 0-4$; $r = 1-2$; $y = 0-6$; $t = 1-4$, and $u = 2-6$; and perfluoro(8-cyano-
5-methyl-3,6-dioxa-1-octene).

16. A composition according to claim 1 further comprising a filler selected from
fluoropolymer filler, carbon black, and combinations thereof.

17. The composition of claim 1 wherein the fluoropolymer is selected from a
fluoroelastomer and a fluoroplastic.

18. The composition of claim 1 wherein the composition has an induction time below about
15 minutes at a temperature of about 175°C .

19. The composition of claim 1 wherein the composition has a scorch resistance greater than
the scorch resistance of a comparative composition tested at the same temperature, which
comparative composition has the same fluoropolymer composition of claim 1 but with a
urotropin curative.

20. The composition of claim 1 further comprising an additional curative material.

21. The composition of claim 20 wherein the additional curative material is selected from ammonia-generating compounds, substituted triazine derivatives, unsubstituted triazine derivatives, peroxides, bis-aminophenols, bis-amidoximes, and organotin compounds.

22. A shaped article comprising the fluoropolymer composition of claim 1.

23. The composition of claim 1 further comprising a fluoropolymer containing interpolymers derived from monomers selected from the group consisting of perfluoroolefins, partially-fluorinated olefins, non-fluorinated olefins, vinylidene fluoride, perfluorovinyl ethers, and combinations thereof.

24. The composition according to claim 23 comprising a curative that increases MDR torque in the fluoropolymer composition at 177°C by at least about 0.01 N m.

25. The composition of claim 23 further comprising a curative material selected from ammonium salts, ammonia-generating compounds, substituted triazine derivatives, unsubstituted triazine derivatives, peroxides, bis-aminophenols, bis-amidoximes, and organotin compounds; and optionally a coagent.

26. The composition of claim 25 wherein the coagent is selected from triallyl cyanurate; triallyl isocyanurate; tri(methylallyl) isocyanurate; tris(diallylamine)-s-triazine; triallyl phosphite; N,N-diallyl acrylamide; hexaallyl phosphoramidate; N,N,N',N'-tetraalkyl tetraphthalamide; N,N,N',N'- tetraallyl malonamide; trivinyl isocyanurate; 2,4,6-trivinyl methyltrisiloxane; and tri(5-norbornene-2-methylene)cyanurate.

27. The composition of claim 25 wherein the additional fluoropolymer includes interpolymers containing a halogen that is capable of participation in a peroxide cure reaction and wherein the additional curative is a peroxide, and optionally further comprising a triallyl cyanurate coagent.

28. A shaped article comprising the fluoropolymer composition of claim 23.

29. The composition of claim 1 wherein RA is selected from the formula $\text{CF}_3(\text{CF}_2)_n\text{COO}^{(-)}$ wherein n is 1, 2, or 6, and wherein QR'_k is selected from tetrabutylphosphonium and tributyl(2-methoxy)propylphosphonium.

30. The composition of claim 1 wherein RA is selected from the formula $(^{-})\text{OOC}(\text{CF}_2)_n\text{COO}^{(-)}$ wherein n is 2 or 4, and wherein QR'_k is selected from tetrabutylphosphonium and tributyl(2-methoxy)propylphosphonium.

31. The composition of claim 1 wherein RA is selected from acetate and benzoate, and wherein QR'_k is selected from tetrabutylphosphonium and tributyl(2-methoxy)propylphosphonium.

32. A method of making a fluoropolymer composition comprising the steps of:

a) forming a mixture comprising a fluoropolymer having interpolymerized units derived from a nitrogen-containing cure site monomer, a catalyst composition comprising a compound having the formula: $\{\text{RA}\}^{(-)}\{\text{QR}'_k\}^{(+)}$ or the precursors thereof added separately or as a mixture, wherein R is a $\text{C}_1\text{-C}_{20}$ alkyl or alkenyl, $\text{C}_3\text{-C}_{20}$ cycloalkyl or cycloalkenyl, or $\text{C}_6\text{-C}_{20}$ aryl or alkylaryl, A is an acid anion or an acid derivative anion group, which may be heterocyclic, Q is P, S, N, As, or Sb, and each R' is, independently, hydrogen or a substituted or unsubstituted $\text{C}_1\text{-C}_{20}$ alkyl, aryl, aralkyl, or alkenyl group, provided that when Q is nitrogen and the only fluoropolymer in the composition consists essentially of a terpolymer of TFE, a perfluorovinylether, and a perfluorovinylether cure site monomer comprising a nitrile group not every R' is H, and k is the valence of Q, and optionally in the presence of an alcohol of the general formula $\text{R}^2\text{-OH}$, wherein R^2 is a $\text{C}_6\text{-C}_{20}$ alkyl group;

b) shaping the mixture;

c) curing the shaped mixture; and optionally

d) heat aging the cured mixture.

33. A method according to claim 32 wherein the catalyst is added in a form selected from a compound and a mixture of catalyst precursors.

34. A method according to claim 32 wherein individual components of the catalyst are separately added to the fluoropolymer composition.

35. A method according to claim 32 wherein the step of curing further comprises press-curing and optionally post-curing.

36. A cured article prepared according to the method of claim 32.

37. A method for increasing the induction period in a curable fluoropolymer composition comprising the steps of:

a) providing a fluoropolymer comprising interpolymers derived from a nitrogen-containing cure site monomer; and

5 b) incorporating, into the fluoropolymer, a catalyst composition that includes a compound having the general formula: $\{RA\}^{(-)}\{QR'_k\}^{(+)}$ or the precursors thereof added separately or as a mixture, wherein R is a C₁-C₂₀ alkyl or alkenyl, a C₃-C₂₀ cycloalkyl or cycloalkenyl or a C₆-C₂₀ aryl or alkylaryl; A is an acid anion or an acid derivative anion; Q is P, S, N, As, or Sb; each R' is, independently, hydrogen or a substituted or unsubstituted C₁-C₂₀ alkyl, aryl, aralkyl, or alkenyl group, provided that when Q is N and the only fluoropolymer in the composition consists essentially of a terpolymer of TFE, a perfluorovinylether, and a perfluorovinylether cure site monomer comprising a nitrile group not every R' is H; and k is the valence of Q.

15 38. The method of claim 37 further comprising the step of incorporating an alcohol of the general formula R²-OH, wherein R² is a C₁-C₂₀ alkyl group, and wherein R² can be fluorinated.

39. The method of claim 37 further comprising the step of:

c) shaping the composition.

40. The method of claim 37 further comprising the step of:

20 d) curing the shaped composition; and optionally

e) heat aging the cured composition.

41. The method of claim 40 wherein the step of curing includes press-curing, and optionally post-curing.

42. A shaped article prepared according to the method of claim 37.